

What is claimed is:

1. A constant temperature distilling process,
comprising the steps of implementing a
5 drain-to-vacuum process using a degassed liquid
to set a constant temperature distillation unit
for vacuum distillation, or a constant temperature
distillation unit for vacuum cooling to an initial
state thereof; and setting a vacuum distilling
10 temperature for said constant temperature
distillation unit for a degassed solution therein
to boil and evaporate at said set vacuum distilling
temperature in said unit; such that an equilibrium
thermal cycling between evaporation and
15 condensation can be maintained throughout said
constant temperature distillation unit, and
evaporation heat and condensate produced in said
constant temperature distilling process are
recovered and collected, respectively.
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2. The constant temperature distilling process as
claimed in claim 1, wherein said constant
temperature distillation unit for vacuum cooling
includes an evaporating vessel, into which
25 constant-temperature degassed solution flows via

corresponding conduits and control valves at a predetermined flow rate, said evaporating vessel being connected to a condenser via a condensing tube for vapors produced by said evaporating vessel to flow into said condenser; a flow regulating valve provided on said condensing tube at a predetermined position for controlling the flow rate of vapors discharged from said evaporating vessel when said evaporating vessel is under a saturated vapor pressure at said set vacuum distilling temperature, and thereby maintaining said evaporating vessel at said desired saturated vapor pressure; a condenser, into and out of which hot circulating solution flows via corresponding conduits and control valves at a predetermined flow rate to absorb evaporation heat of vapors produced by said evaporating vessel and flown into said condenser, so that said hot circulating solution is heated to a higher temperature and said vapors are condensed into liquid, which is then discharged into and collected with a vacuum vessel; and a lower vessel and parts thereof being located below said evaporating vessel with a predetermined height difference existed between them for producing vacuums in said conduits, said evaporating vessel,

and said condenser through which said degassed solution, said vapors, or said condensed liquid flows.

5 3. The constant temperature distilling process as claimed in claim 1, wherein said constant temperature distillation unit for vacuum distillation includes an evaporating vessel; and a liquid-gas interface provided in said evaporating vessel, into and out of which a hot circulating solution flows via corresponding conduits and control valves at a predetermined flow rate, and said hot circulating solution providing evaporation heat through a heat transfer at said liquid-gas interface to evaporate said degassed solution in said evaporating vessel.

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25 4. The constant temperature distilling process as claimed in claims 2 and 3, further comprising the step of vacuumizing said conduits, said evaporating vessel, and said condenser, through which said degassed solution, said vapors, or said condensed liquid flows, through implementing said drain-to-vacuum process using said degassed liquid to set said constant temperature distillation unit

for vacuum distillation to an initial state;
sealing said conduits, said evaporating vessel,
and said condenser; closing said flow regulating
valve; filling said vacuumized evaporating vessel
5 with said degassed solution to a predetermined
liquid level; and finally, setting the vacuum
distilling temperature for said evaporating vessel;
wherein said vacuum distilling temperature being
lower than temperatures of said degassed solution
10 and said hot circulating solution flown into said
evaporating vessel and said liquid-gas interface,
respectively.

5. The constant temperature distilling process as
15 claimed in claim 4, further comprising the steps
of causing said degassed solution and said hot
circulating solution to continuously flow into and
out of said evaporating vessel and said liquid-gas
interface, respectively, for said evaporating
vessel to continuously produce vapors; opening said
20 flow regulating valve when said evaporating vessel
reaches said saturated vapor pressure at said
vacuum distilling temperature, in order to allow
said vapors produced by said evaporating vessel
to flow into said condenser and thereby maintaining
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5 said evaporating vessel at a stable saturated vapor pressure; and regulating said flow regulating valve to decrease a flow rate of said vapors being discharged when said degassed solution or said hot circulating solution providing evaporation heat has a flow-out temperature lower than said vacuum distilling temperature, or regulating said flow regulating valve to increase a flow rate of said vapors being discharged when said degassed solution or said hot circulating solution providing evaporation heat has a flow-out temperature higher than said vacuum distilling temperature.

10 6. The constant temperature distilling process as claimed in claim 5, wherein said equilibrium thermal cycling between evaporation and condensation is obtained by keeping said hot circulating solution providing evaporation heat at a temperature higher than that of said hot circulating solution recovering evaporation heat, so that said evaporating vessel has a working temperature higher than that of said condenser.

15 20 25 7. The constant temperature distilling process as claimed in claim 4, wherein said drain-to-vacuum

process is implemented only to partially vacuumize said evaporating vessel when said degassed liquid used in said drain-to-vacuum process is the same as said degassed solution.

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8. The constant temperature distilling process as claimed in claim 5, further comprising the step of implementing said drain-to-vacuum process using said degassed solution for a second time to set said constant temperature distillation unit for vacuum distillation or vacuum cooling to the initial state and thereby resume said unit to a desired degree of vacuum when air remained in said degassed solution continuously accumulates in said conduits, said evaporating vessel, and said condenser, through which said degassed solution, said vapors, or said condensed liquid flows, to produce a pressure high enough to affect said vacuum distilling temperature set for said degassed solution.

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9. A multi-stage vacuum distilling process for solution separation, comprising the steps of providing a tower-like multi-stage vacuum distilling system; setting said multi-stage vacuum

distilling system to an initial state thereof; performing a constant temperature distilling process, transferring of solutions, and recycling of a hot circulating solution to separate said solution and recover most part of heat energy for use repeatedly; and setting a vacuum distilling temperature for each stage of said multi-stage vacuum distilling system according to a temperature gradient of said hot circulating solution, so that said solution separation is achieved in the form of multi-stage vacuum distillation; wherein both said vacuum distilling temperature and a saturated vapor pressure corresponding thereto decrease from upper to lower stages in said multi-stage vacuum distilling system, allowing expanded ranges of usable vacuum distilling temperature and pressure as well as an increased number of vacuum distilling stages and more of said solution separable with one unit of energy.

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10. The multi-stage vacuum distilling process for solution separation as claimed in claim 9, wherein said multi-stage vacuum distilling system includes fore-treatment equipment including heaters separately for heating a degassed solution and said

hot circulating solution to a set temperature; a plurality of constant temperature distillation units for vacuum distillation sequentially stacked one by one into a tower-like structure, in which

5 a first stage, or the highest stage, is stacked over a second stage, the second stage is stacked over a third stage, etc., and in-flow conduits of one said constant temperature distillation unit at a lower stage are connected at a distal end to

10 corresponding out-flow conduits of one said constant temperature distillation unit at an upper stage; and post-treatment equipment including vacuum vessels separately for collecting condensate and concentrated solution, a first heat

15 exchanger for lowering a temperature of said hot circulating solution discharged at the last stage, a second heat exchanger for keeping said vacuum vessel for collecting said condensate at a set temperature, a common lower vessel and parts thereof for producing vacuums in said constant temperature distillation units for vacuum distillation, and a circulation pump for said hot circulating solution.

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25 11. The multi-stage vacuum distilling process for

solution separation as claimed in claim 10, wherein
said step of setting said multi-stage vacuum
distilling system to an initial state thereof is
performed by sequentially setting said constant
temperature distillation units for vacuum
distillation to their initial state one by one from
lower to upper stages; and wherein in said step
of setting a vacuum distilling temperature for each
stage of said multi-stage vacuum distilling system
according to a temperature gradient of said hot
circulating solution, said temperatures set for
said multiple stages of said vacuum distilling
system decrease from upper to lower stages, so that
a saturated vapor pressure at the temperature set
for each vacuum distillation stage decreases from
upper to lower stages.

12. The multi-stage vacuum distilling process for
solution separation as claimed in claim 10, wherein
said step of transferring solutions further
includes the steps of causing said degassed
solution heated to a set temperature to
continuously flow into said evaporating vessel at
each stage from upper to lower stages at a
predetermined flow rate; allowing said degassed

solution to evaporate at each stage, so that said
degassed solution has a concentration gradually
increases from upper to lower stages or forms
crystalline precipitate therein; collecting said
concentrated solution discharged at the last stage
with said vacuum vessel; subjecting said collected
concentrated solution to further solute
concentration using vacuum freezing and drying;
filtering off any crystalline precipitate before
said degassed solution flows into said evaporating
vessel at the next lower stage, if there is
crystalline precipitate in said evaporating vessel;
and collecting said crystalline with a vacuum
vessel.

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13. The multi-stage vacuum distilling process for
solution separation as claimed in claim 10, wherein
said step of recycling a hot circulating solution
further includes the steps of causing said hot
circulating solution heated to a set temperature
20 to continuously flow into and out of a liquid-gas
interface at each stage from upper to lower stages
at a constant flow rate to provide said degassed
solution with required evaporation heat, so that
the temperature of said hot circulating solution

decreases from upper to lower stages; using said
first heat exchanger to lower the temperature of
said hot circulating solution discharged at the
last stage; and using said circulation pump to cause
5 said hot circulating solution to continuously flow
into and out of a condenser at each stage from lower
to upper stages to absorb evaporation heat and
thereby condense produced vapors to condensate,
so that the temperature of said hot circulating
10 solution increases from lower to upper stages; and
allowing said hot circulating solution to flow back
to said heater for heating said circulating
solution.

15 14. The multi-stage vacuum distilling process for
solution separation as claimed in claim 9, wherein
said temperature gradient of said hot circulating
solution is set according to a liquid-gas
equilibrium curve of said degassed solution and
then used to set the vacuum distilling temperature
20 at each stage of vacuum distillation, enabling the
forming of non-overlapped temperature ranges for
different stages, and a trapezoidal temperature
curve showing said temperature gradient of said
hot circulating solution flowing through each
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vacuum distilling stage.

15. A multi-stage vacuum cooling and freezing process
for solution separation, which utilizes freezing
5 and melting to produce condensate and may be used
to assist in multi-stage vacuum distillation to
increase the number of stages thereof, comprising
the steps of providing and combining a tower-like
multi-stage vacuum cooling system and a tower-like
10 multi-stage vacuum freezing system; setting said
multi-stage cooling and freezing systems to an
initial state thereof; and performing transferring
of solutions, a constant temperature distilling
process, and a drain-to-vacuum and freezing process
15 to produce ice crystals in a degassed solution;
wherein said multi-stage vacuum freezing system
using a low-temperature solution discharged at the
lowest stage of said multi-stage vacuum cooling
system as an initial solution needed to perform
said multi-stage vacuum freezing to save energy
needed for pre-cooling, and using vapors produced
20 in multi-stage vacuum distilling and cooling
processes as condensation heat required to melt
said ice crystals produced in said degassed
solution; low-temperature concentrated solution
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and molten ice crystals produced through said
multi-stage vacuum freezing process being used to
cool a hot circulating solution discharged from
the last stage of multi-stage vacuum distillation
5 and to maintain the temperature of a vacuum vessel
for collecting the condensate produced in said
multi-stage vacuum distillation, enabling an
expanded distilling temperature range and
accordingly increased stages for the multi-stage
10 distillation and increased yield of solution
separable with one unit of energy.

16. The multi-stage vacuum cooling and freezing process
for solution separation as claimed in claim 15,
15 wherein said multi-stage vacuum cooling system
includes a plurality of constant temperature
distillation units for vacuum cooling sequentially
stacked one by one into a tower-like structure,
in which a first stage, or the highest stage, is
20 stacked over a second stage, the second stage is
stacked over a third stage, etc., with in-flow
conduits of one said constant temperature
distillation unit for vacuum cooling at a lower
stage connected at a distal end to corresponding
25 out-flow conduits of one said constant temperature

distillation unit for vacuum cooling at an upper stage; and a common lower vessel and parts thereof for said a plurality of constant temperature distillation units for vacuum cooling.

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17. The multi-stage vacuum cooling and freezing process for solution separation as claimed in claim 16, wherein said multi-stage vacuum freezing system includes a plurality of freezing vessels sequentially stacked one by one into a tower-like structure, in which a first stage, or the highest stage, is stacked over a second stage, the second stage is stacked over a third stage, etc.; a liquid-solid interface provided in each of said freezing vessels for heat transfer; a condenser that enables releasing of condensation heat and evaporation heat from said degassed solution; a plurality of conduits and control valves thereof connecting said multi-stage vacuum freezing system to said multi-stage vacuum distillation system and said multi-stage vacuum cooling system to allow vapors produced through multi-stage vacuum distillation and multi-stage vacuum cooling to separately flow into said freezing vessel at each stage; a plurality of conduits and control valves

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thereof cooperating with said lower vessel and parts thereof provided for said multi-stage vacuum cooling system to produce vacuums in said conduits and said freezing vessels through which said degassed solution, said produced vapors, or said condensate flow; and vacuum vessels separately for collecting molten ice crystals and low-temperature concentrated solution produced in said multi-stage vacuum freezing process.

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18. The multi-stage vacuum cooling and freezing process for solution separation as claimed in claim 17, wherein said step of setting said multi-stage vacuum cooling system to an initial state thereof is performed by sequentially setting said constant temperature distillation units for vacuum cooling to their initial state one by one from lower to upper stages, and then setting a temperature of vacuum cooling for each stage of said multi-stage vacuum cooling system; and said temperatures set for said multiple stages of said vacuum cooling system decrease from upper to lower stages, so that a saturated vapor pressure at the temperature set for each vacuum cooling stage decreases from upper to lower stages.

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19. The multi-stage vacuum cooling and freezing process
for solution separation as claimed in claim 17,
wherein said step of setting said multi-stage
vacuum freezing system to an initial state thereof
5 is performed by implementing the drain-to-vacuum
process using a degassed liquid for all stages one
by one from bottom to top to vacuumize said freezing
vessels and said conduits through which said
degassed solution, said vapors, or said condensate
10 flow, and then seal said freezing vessels and said
conduits.

20. The multi-stage vacuum cooling and freezing process
15 for solution separation as claimed in claim 17,
wherein said step of transferring solutions further
includes the steps of fully filling said freezing
vessel at the first stage with said low-temperature
solution discharged at the last stage of said
20 multi-stage vacuum cooling system; implementing
the drain-to-vacuum and freezing process to produce
ice crystals in said freezing vessel at the first
stage of said multi-stage vacuum freezing system;
causing each of said freezing vessels at a higher
25 stage to completely discharge all said degassed

solution that has not yet frozen into ice crystals
to said freezing vessel at the next lower stage
or said vacuum vessel; guiding said vapors produced
in said multi-stage vacuum distilling and cooling
processes to said freezing vessel at the first stage
of said multi-stage vacuum freezing system to melt
said ice crystals produced in said freezing vessel;
collecting said molten ice crystals with said
vacuum vessel for molten ice crystals; implementing
the drain-to-vacuum and freezing process in said
freezing vessel at the next lower stage of said
multi-stage vacuum freezing system or collecting
said low-temperature concentrated solution with
said vacuum vessel for low-temperature
concentrated solution; and filtering off
crystalline precipitate, if any, in said freezing
vessel at an upper stage before said degassed
solution flows into said freezing vessel at a lower
stage; and collecting said crystalline with a
vacuum vessel.

21. The multi-stage vacuum cooling and freezing process
for solution separation as claimed in claim 17,
wherein said drain-to-vacuum and freezing process
further includes the steps of filling said

vacuumized freezing vessel having said
liquid-solid interface provided therein with a
predetermined amount of a low-temperature solution;
implementing the drain-to-vacuum process to
5 discharge said low-temperature solution at a
predetermined speed to said vacuumized freezing
vessel at the next lower stage or to said vacuum
vessel; and using said condenser to continuously
release said condensation heat and said evaporation
heat in said freezing vessels for said solution
10 in said freezing vessels to freeze into ice crystals
on surfaces of said liquid-solid interfaces; said
ice crystals forming at an increased speed when
a vacuum volume in each of said freezing vessels
increases, and ice crystals having even composition
15 being finally formed on said liquid-solid
interfaces in said freezing vessels.